Space Weather Technical Forecast

Issued on Friday, 05 January 2024 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares with a slight chance of X-flares. S1 Proton Storming continues, with a further risk 08 or 09 January. CME arrival forecast on 08 or 09 January.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Low, with a peak C3.7 flare observed at 05/0809 UTC from the region of AR3534 in the southwest quadrant. This is one of a number of C-class flares from AR3534, AR3536 and an emerging region close to the southeast limb. There are seven sunspot regions on the visible disc, with only four regions numbered. AR3536 has a persistent delta spot, with AR3538 also exhibiting beta-gamma characteristics. The region on the southeast limb, also appears to be revealing increasing complexity as it rotates further into view. A CME was observed leaving the region of AR3536 at around 04/2300UTC appears to have an Earth-directed component. A further CME observed at around 05/0100UTC appears to have emanated from close to the southeast limb and may have left from the newly emerging region on the limb. No further CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar winds have been slightly elevated averaging around 400-450km/s under the waning influence of coronal hole 86. Density has been around average. Total interplanetary magnetic field strength, IMF, has been weak, with the north-south component varying weakly. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity has been Quiet to Unsettled throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux started above the S1/Minor Storm threshold but has followed a generally steady decline below the threshold, with a brief enhancement around 05/0000UTC, peaking at 21.8pfu at 04/2335 UTC which has yet to be attributed to a specific cause. GOES16 high energy (greater than 2MeV) electron flux was at background levels. The 24-hour fluence was below Active throughout, with a flat trend. The 05/0000 UTC observation was 1.59e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is forecast, with a very slight chance of X-class flaring.

Solar Wind / Geomagnetic Activity: A CME which left the Sun from the northeast quadrant late on 04 January may glance the Earth either late on 08 or during 09 January. Solar wind speeds are expected to decline to background, with a high speed stream from coronal hole 89 forecast to connect with the Earth either late on 08 or during 09 January, with estimated speeds of 400-500km/s. Geomagnetic activity is forecast to start Quiet to Unsettled. Active intervals are then possible on 08 or 09 January, with a slight chance of G1/Minor Storm intervals due either to the high speed stream, CME or a combination of both.

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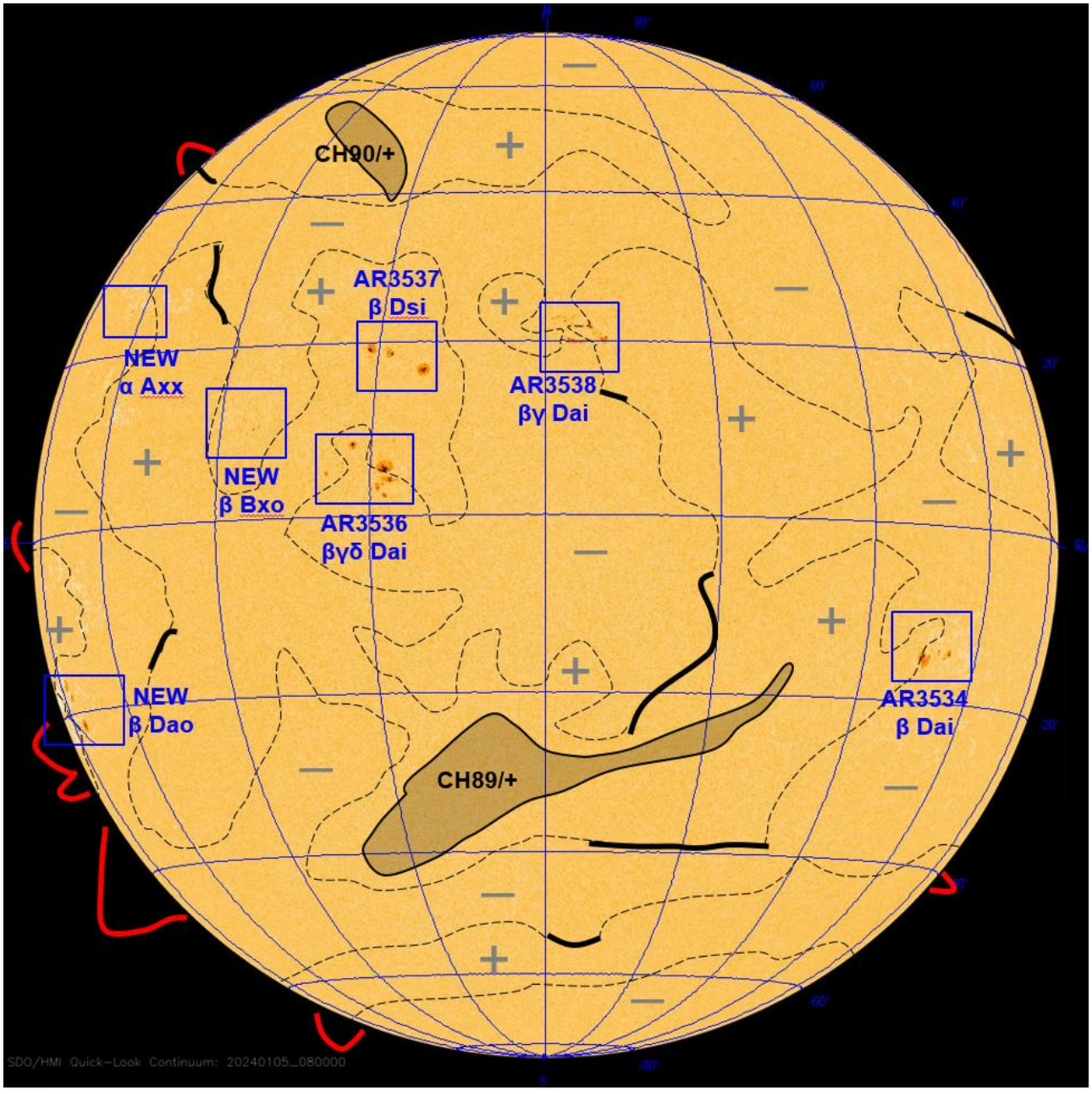
Energetic Particles / Solar Radiation: GOES16 high energy proton flux is below the S1/Minor Storm threshold. This is expected to follow a declining trend, but with a risk of further increases above the threshold on 08 or 09 January due to the CME arrival. GOES16 high energy electron flux is likely to remain at predominantly background levels at first, with a chance of Moderate levels later in the period, dependent on the interaction of the coronal hole high speed stream connection and CME arrival.

Figure 1. Solar Analysis Valid 05/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

Two CMEs have been analysed in the last 24 hours. One was on the eastern limb and is not expected to affect the Earth. A further CME from the northeastern quadrant is forecast to perhaps glance the Earth either late on 08 January or during 09 January, with medium confidence in some effects at Earth.

Otherwise, the high speed stream from coronal hole 86 continues to wane. Ambient solar wind speeds are then likely through much of 06 and 07 January. The high speed stream from coronal hole 89 may then connect with the Earth on 08 January, with speeds in the region of 400-500km/s possible, these then continuing into 09 January. This coronal hole is a recurrent feature which produced limited effects on the previous rotation, but which is stronger on this rotation. As the coronal hole high speed stream and CME are forecast to affect the Earth around the same time, there is uncertainty about potential speeds, with the speed of the CME also forecast at around 400-450km/s.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through 05 and 06 January. There is then a slight chance of Active periods and a very slight chance of G1/Minor storms on 08 and 09 January due to the potential coincident arrival of the high speed stream and CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	15	15
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
05/0936	Partial	Filament eruption	NE quadrant	400-450km/s	08/1200 UTC +/- 12 hours	Glancing shock possible.

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Figure 2: MOSWOC Enlil model showing anticipated time of CME arrival (white circle).

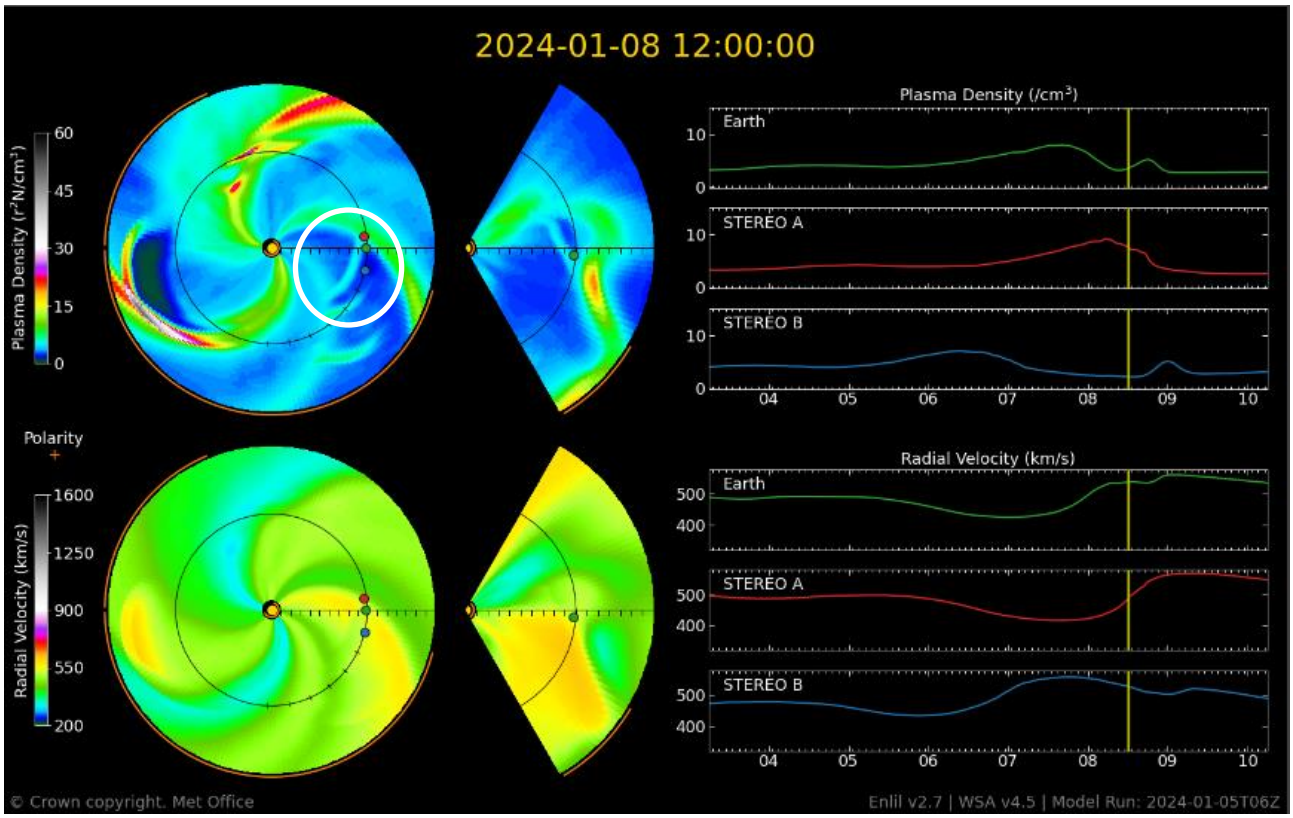
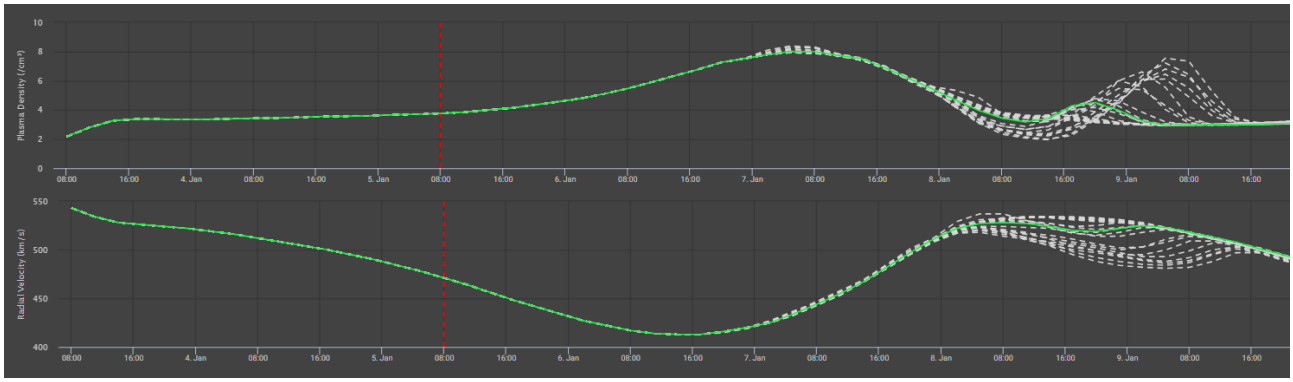


Figure 3: MOSWOC Enlil ensemble, showing potential range of CME arrival times.



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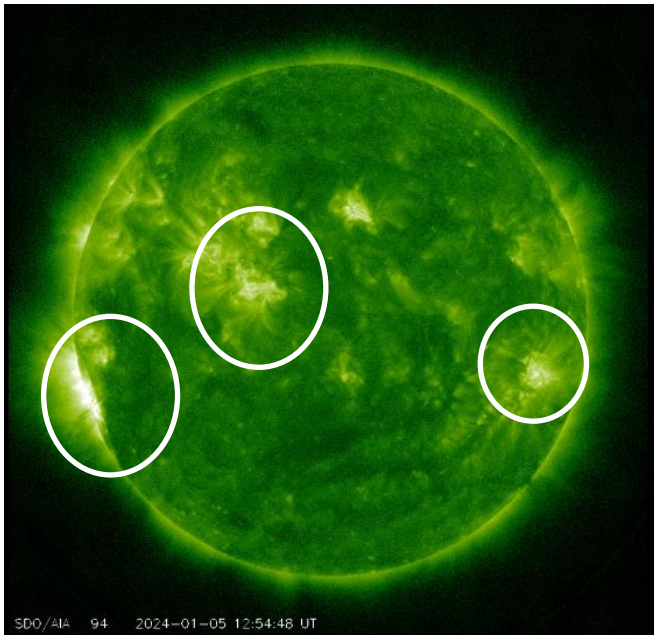
Radio Blackouts - X-Ray Flares:
Activity has been Low over the last 24 hours with the majority of activity observed from AR3534, AR3536 and an emerging region close to the southeast limb. A filament eruption close to AR3536 late on 05 January, associated with a C-class flare appears to have an Earth-directed component.

AR3536 is the most complex region on the disc with a resilient Delta spot in the central region. AR3538 in the north-centre disc is also complex with a beta-gamma configuration but is less active. A region on the southeast limb is continuing to reveal increase complexity and has already produced a non-Earth-directed CME.

Low to Moderate activity is forecast with a slight chance of X-class flaring.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: SDO-AIA 94 image with the three risk regions circled.



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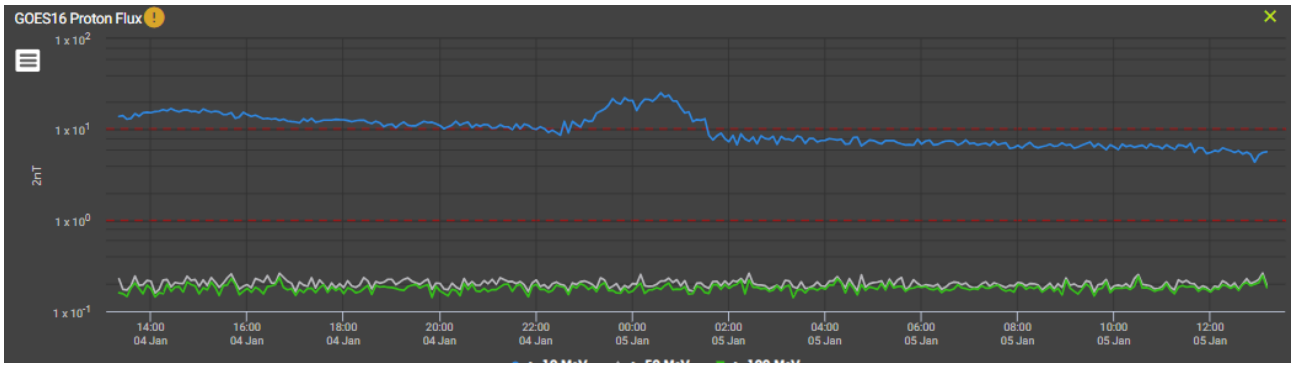
Solar Radiation Storms - (High Energy Protons):
GOES16 high energy (greater than 10MeV) proton flux is currently below the S1/Minor Storm threshold, on a steady downward trend.

Brief increases above the S1/Minor Storm level as possible with a declining risk through 05 and 06 January, with a proton enhancement still possible in the radiation belts.

There appears to have been a slight increase in low energy protons observed at ACE following the CME from the northeast quadrant. This CME is due to glance the Earth on 08 or 09 January, with a risk of further proton enhancements.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	60	30	40	40
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-proton flux for the last 24 hours



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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is expected to be at background levels through 05 and 06 January in the presence of a benign solar wind environment. Uncertainty increases through 08 and 09 January as a potential coincident high speed stream and CME arrival could lead to an eventual increase in the electron flux. However the precise timing and strength of each of the events will determine the timeline of increase and decreases in electron flux values.

Electron fluence values are well below the Active threshold. A rising trend may become evident later in the period should there be a sustain rise in flux levels. This is however subject to low confidence.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	1	5	5
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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